



## **PAVEMENT CAUSED FOD TO AIRCRAFT ENGINES**

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### **Transportation Systems 2004 Workshop**

Fort Lauderdale, Florida

30 March 2004

Naval Facilities Engineering Service Center  
Port Hueneme, California

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## Objective Of Study



- **Determine what percentage of “Foreign Object Debris” (FOD) damaged aircraft engines were caused by pavement material:**
  - AC fragments
  - PCC fragments
  - Joint Seal
- **This information will assist in determining if the critical PCI thresholds being used by the Navy should be tightened to a higher level to reduce FOD probabilities.**

# FOD Data Sources



- **Engine FOD Incident Reports**
  - Required by OPNAVINST 4790.2H for each damaged engine
- **Reports Reviewed: 843**
- **Report Sources:**
  - Commander, Naval Air Force, Atlantic Fleet
  - Commander, Naval Air Force, Pacific Fleet
  - Commander, Strike Fighter Wing, Pacific Fleet
  - Commander, Strike Fighter Wing, Atlantic Fleet
  - Commander, Third Marine Air Wing

# Engine FOD Incident Reports



- **Contents of reports:**
  - Aircraft – Type, model, series
  - Engine – Type, model, series, serial number, installed position
  - Julian Date engine damaged by FOD
  - Julian Dates and type of last maintenance
  - Aircraft Location when damaged by FOD
  - Engine Repair/Replacement Cost Data
  - Damage Investigation Results
    - Evidence
    - Analysis of evidence
    - FOD identification, or suspected object and material if identification not possible
  - Corrective action to prevent recurrence
  - Commanding Officer's comments

## FOD Identification



- Done visually by aircraft operators
- Degree of Difficulty in assigning cause in this study:
  - Simple - Actual object recovered or good evidence of actual object
  - Intermediate - Suspected objects missing forward of engine intake or evidence at damaged site (e.g., rubber residue, metal, glass)
  - Unknown – Evidence/description of cause lacking in report

# Damage Caused By Fastener

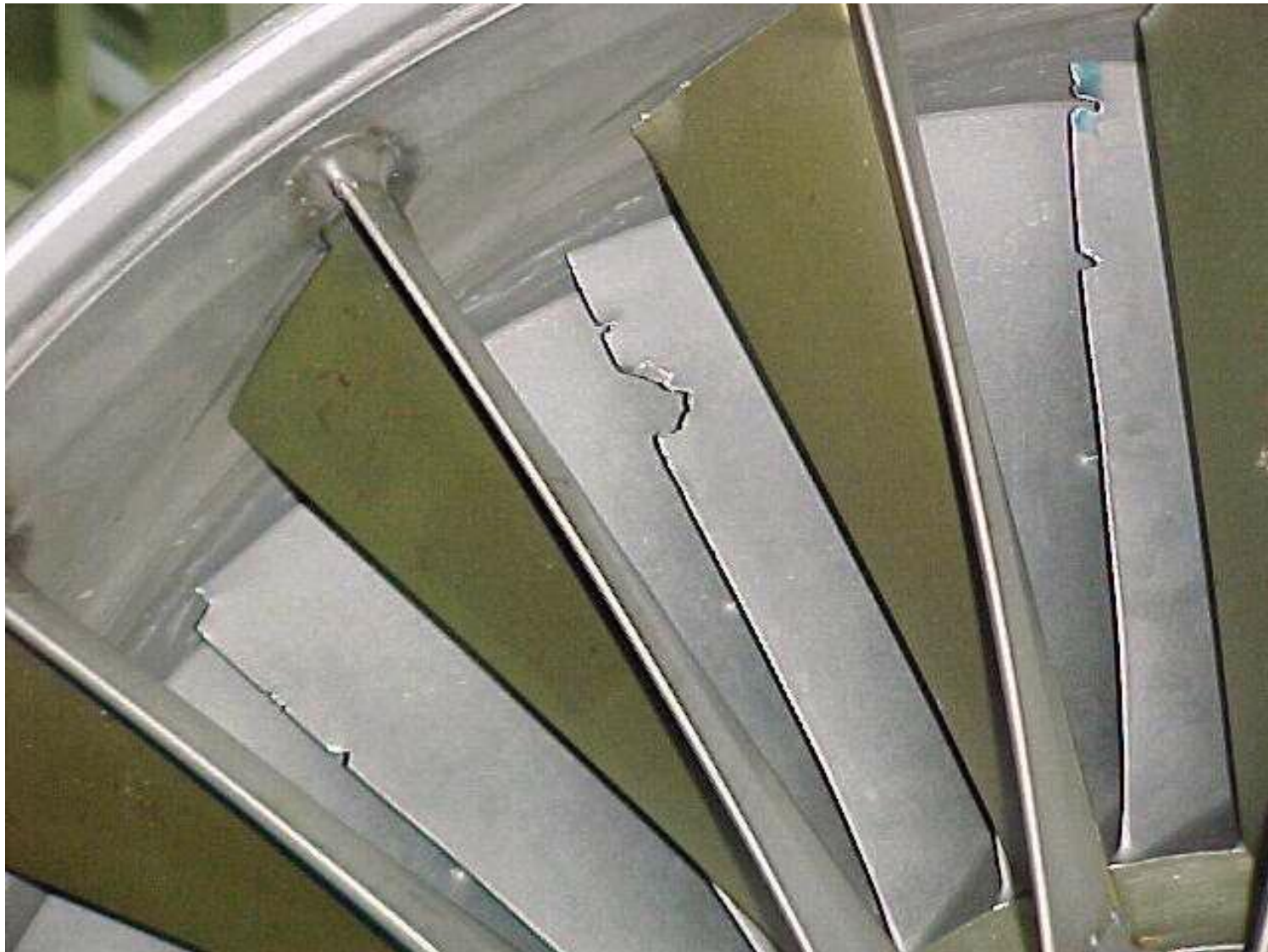
(Photo Courtesy of Failure Analysis Service Technology)





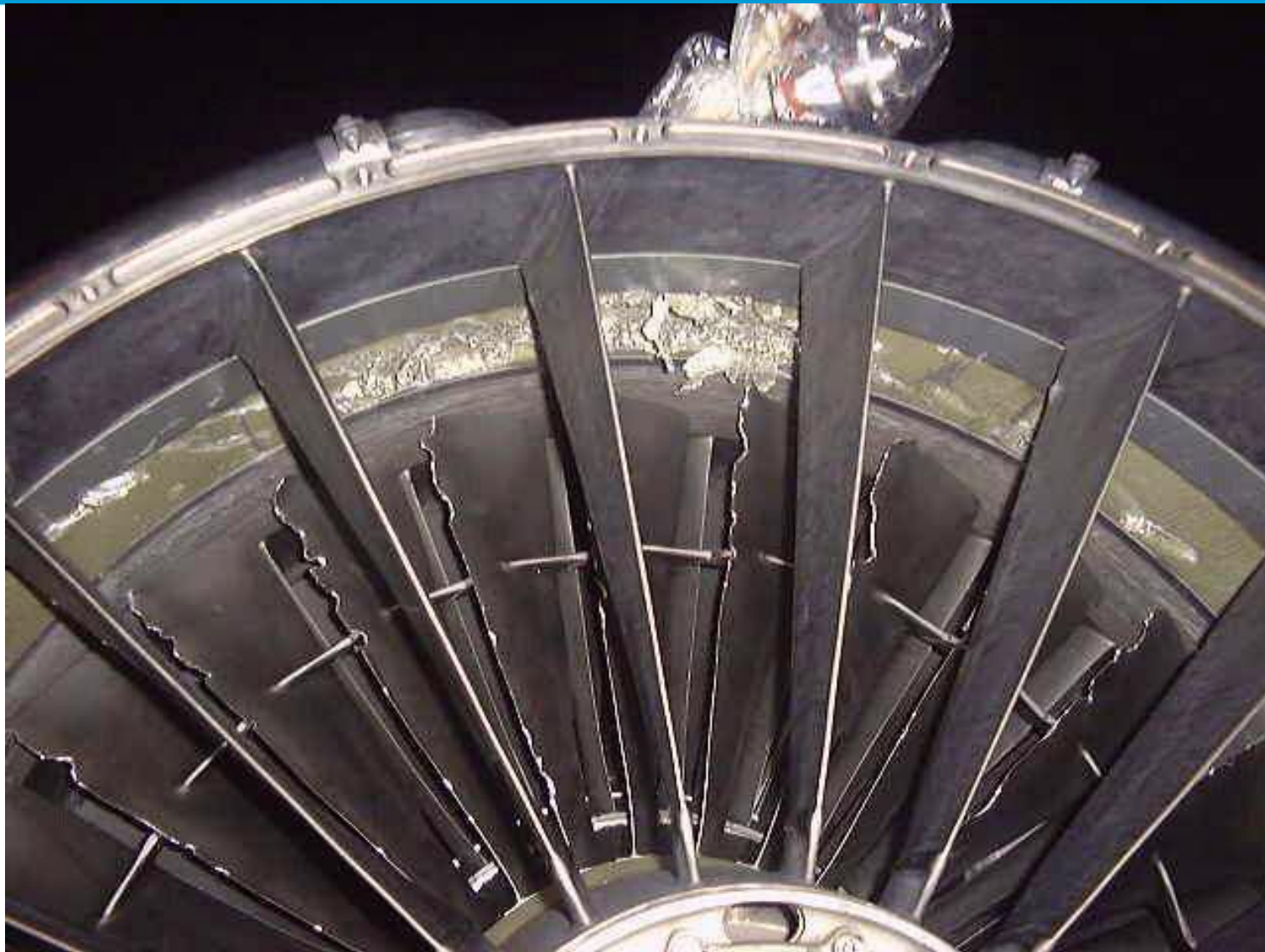
# Damage Caused By Concrete

(Photo Courtesy of Failure Analysis Service Technology)



# Damage Caused By a Tool

(Photo Courtesy of Failure Analysis Service Technology)





# Damage Caused by Hard Ice

(Photo Courtesy of Failure Analysis Service Technology)



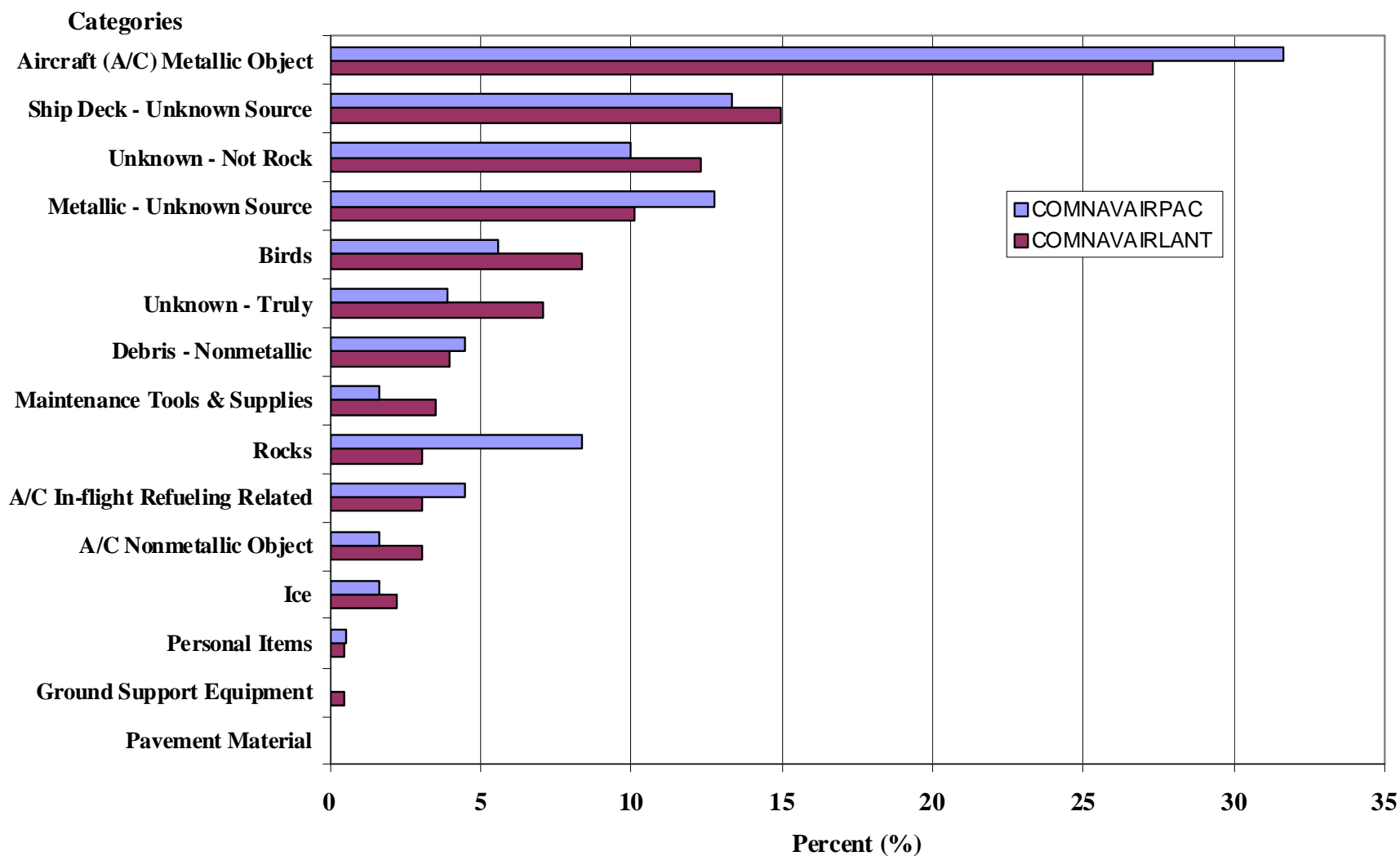
## FOD Incidents – January 2002 through March 2003



Cause	Total Incidents	Percent
Aircraft Metallic Object	119	29.2
Ship Deck – Unknown Source	58	14.3
Metallic – Unknown Source	46	11.3
Unknown – Not Rock	46	11.3
Birds	29	7.1
Unknown – Truly	23	5.7
Rocks	22	5.4
Debris – Nonmetallic	17	4.2
Aircraft In-flight Refueling Related	15	3.7
Maintenance Tools and Supplies	11	2.7
Aircraft Nonmetallic Object	10	2.5
Ice	8	2.0
Personal Items	2	0.5
Ground Support Equipment	1	0.2
Pavement Material	0	0.0
<b>Totals:</b>	<b>407</b>	<b>100.0</b>

# COMNAVAIRLANT & COMNAVAIRPAC FOD Incidents

(January 2002 – March 2003)

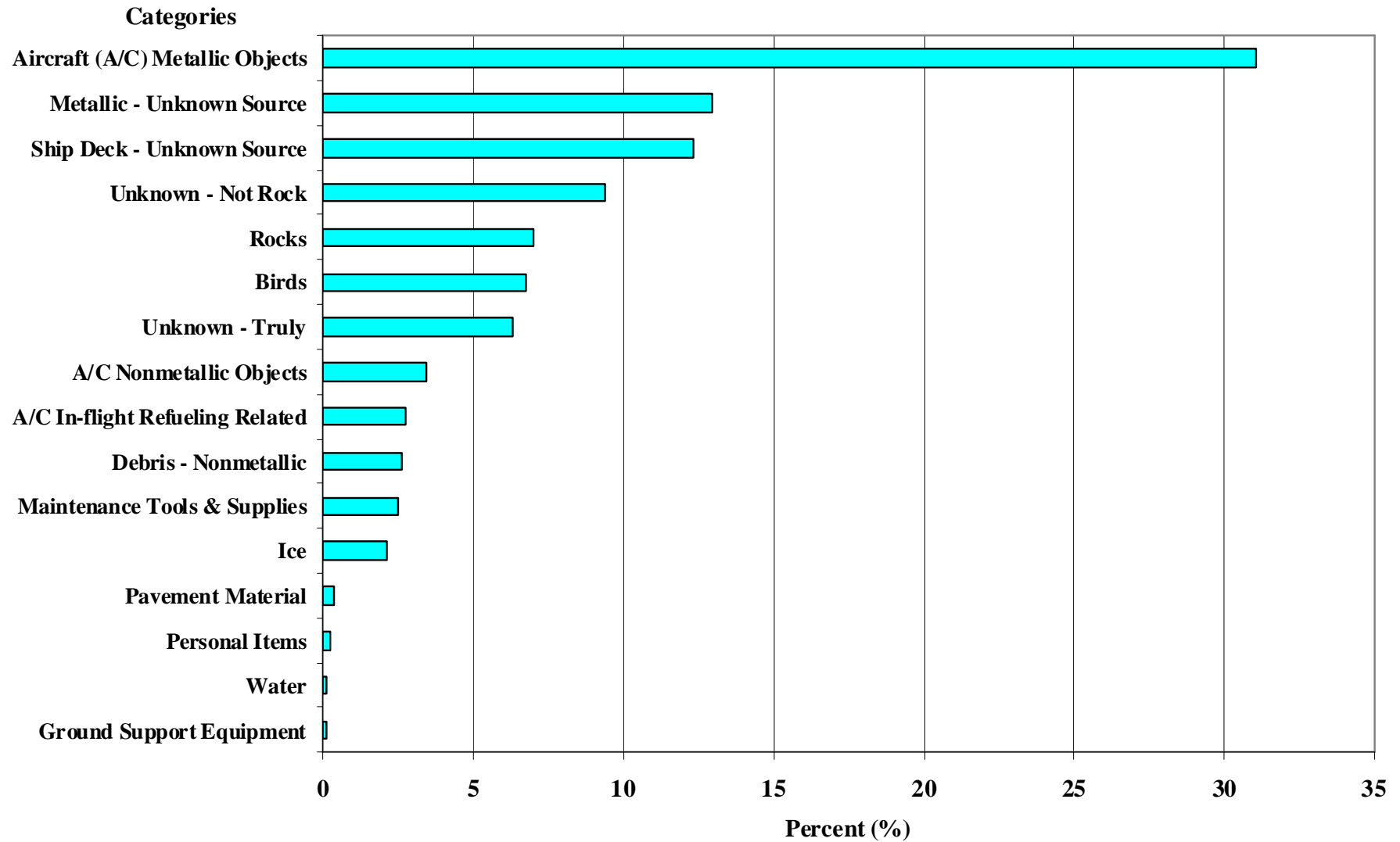


## FOD Incidents – All Collected Data



Cause	Total Incidents	Percent
Aircraft Metallic Object	262	31.1
Metallic – Unknown Source	109	12.9
Ship Deck – Unknown Source	104	12.3
Unknown – Not Rock	79	9.4
Rocks	59	7.0
Birds	57	6.8
Unknown – Truly	53	6.3
Aircraft Nonmetallic Object	29	3.4
Aircraft In-flight Refueling Related	23	2.7
Debris – Nonmetallic	22	2.6
Maintenance Tools and Supplies	21	2.5
Ice	18	2.1
Pavement Material	3	0.4
Personal Items	2	0.2
Ground Support Equipment	1	0.1
Water	1	0.1
Totals:	843	100

## FOD Incidents – All Collected Data





## Rock and Pavement FOD



<b>FOD Material</b>	<b>Number Incidences</b>	<b>Standard Cost (\$)</b>
<b>Rocks</b>	<b>59</b>	<b>8,015,000</b>
<b>Pavement</b>	<b>3</b>	<b>226,000</b>

## Findings



- **For period Jan 02 thru Mar 03 for COMNAVAIRLANT & COMNAVAIRPAC:**
  - Majority of engine damaged were caused by objects from:
    - Aircraft Itself
    - Ship deck
    - In-flight refueling equipment
    - Unknown sources (not rock or truly unknown)
  - Pavement FOD: None
- **For all 843 collected data:**
  - Majority of engine damaged were caused by: (same as above)
  - Pavement FOD: 3 (0.4%)
  - Rock FOD: 59 (7.0%)
  - Rock caused damage is more prevalent at Air Stations in arid western United States
  - Insufficient data to determine existence of correlation between engine height and FOD caused engine damage

## Conclusion



- **Based on findings from this study, the critical PCI threshold levels should remain unchanged for Navy and Marine Corps airfield pavements.**